U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-259 772

Pelican Lake, Bottineau County, North Dakota

National Eutrophication Survey, Corvallis, Oreg

Prepared for

Corvallis Environmental Research Lab, Oreg

Sep 76

323050

PB 259 772

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

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NATIONAL TECHNICAL
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U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

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REPORT
ON
PELICAN LAKE
BOTTINEAU COUNTY
NORTH DAKOTA
EPA REGION VIII
WORKING PAPER No. 574

WITH THE COOPERATION OF THE
NORTH DAKOTA STATE DEPARTMENT OF HEALTH
AND THE
NORTH DAKOTA NATIONAL GUARD
SEPTEMBER, 1976

TECHNICAL REPORT DATA *(Please read Instructions on the reverse before completing)*		
1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Report on Pelican Lake, Bottineau County, North Dakota		5. REPORT DATE Prepared September 1976 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)		8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 574
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Eutrophication Survey U.S. Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460		13. TYPE OF REPORT AND PERIOD COVERED Final - 1974 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading ia		05B 05C

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release unlimited		24
	20. SECURITY CLASS *(This page)*	22. PRICE PB 73-350-340

EPA Form 2220-1 (9-73)

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the North Dakota State Department of Health for professional involvement, to the North Dakota National Guard for conducting the tributary sampling phase of the Survey, and to those North Dakota wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

Norman L. Peterson, Director, and the staff of the Division of Water Supply and Pollution Control of the Department of Health, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

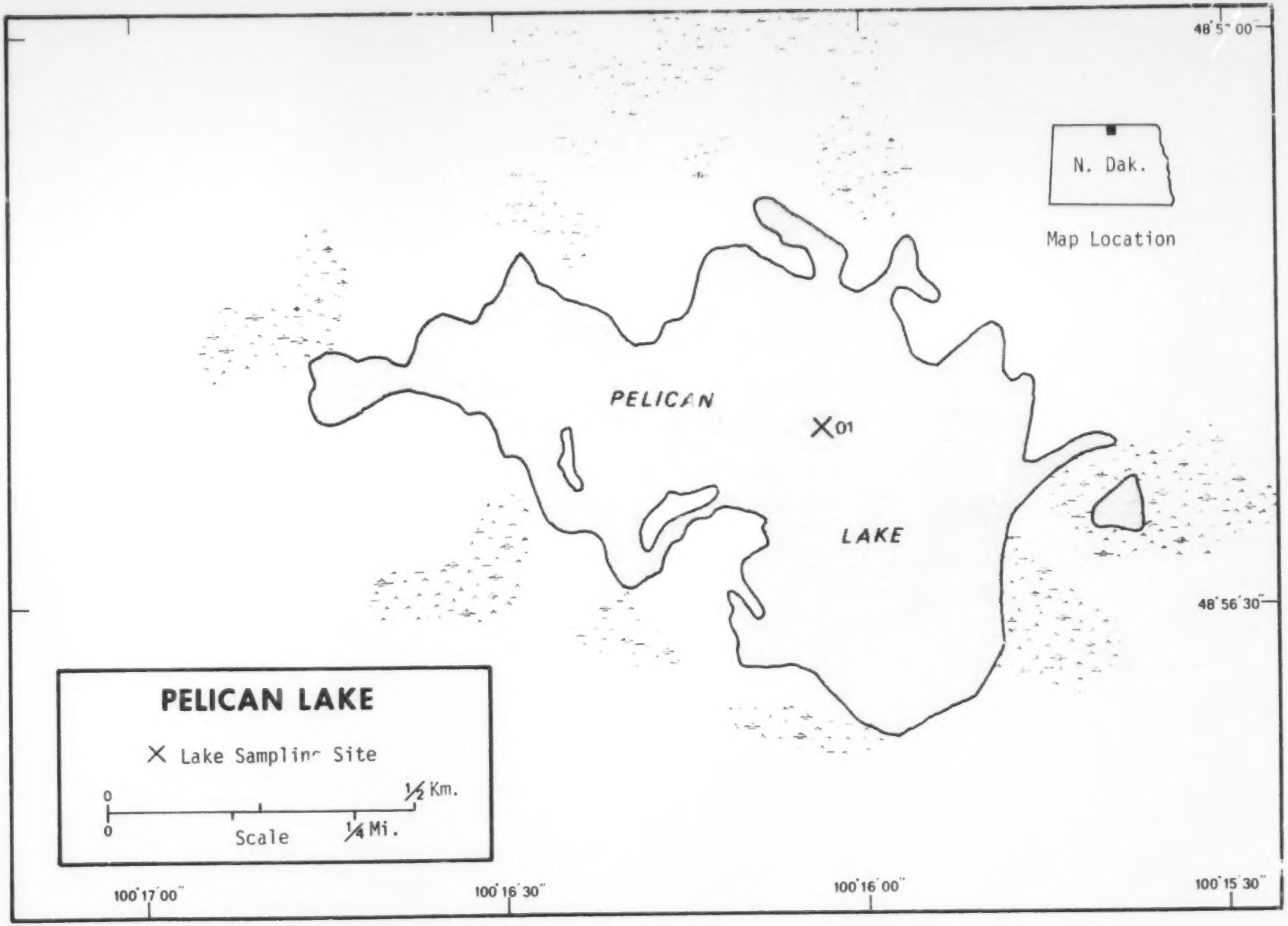
Major General LaClair A. Melhouse, the Adjutant General of North Dakota, and Project Officer Colonel Irvin M. Sande, who directed the volunteer efforts of the North Dakota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES AND RESERVOIRS

STATE OF NORTH DAKOTA

NAME	COUNTY
Ashtabula	Barnes, Griggs
Audubon	McLean
Brush	McLean
Darling	Renville, Ward
Devils	Benson, Ramsey
Jamestown	Stutsman
LaMoure	LaMoure
Matejcek	Walsh
Metigoshe	Bottineau
Pelican	Bottineau
Sakakawea	Dunn, McKenzie, McLean, Mercer, Mountrail, Williams
Spiritwood	Stutsman
Sweet Briar	Morton
Whitman	Nelson, Walsh


48°57'00"
N. Dak.
Map Location
PELICAN
LAKE
X01
48°56'30"
PELICAN LAKE
X Lake Sampling Site
0
0
Scale
1/4 Mi.
1/2 Km.
100°17'00"
100°16'30"
100°16'00"
100°15'30"

PELICAN LAKE

STORET NO. 3811

I. INTRODUCTION

Pelican Lake was included in the National Eutrophication Survey as a water body of interest to the North Dakota Department of Health. Tributaries and nutrient sources were not sampled, and this report relates only to the lake sampling data.

Pelican Lake is a controlled woodland lake which primarily is used for fishing. There are no waste loads into the lake other than those from nearby marshy areas. The principal source of water to the lake is runoff from surrounding wooded areas (Peterson, 1974).

II. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Pelican Lake is meso-eutrophic. It ranked second in overall trophic quality when the 14 North Dakota lakes sampled in 1974 were compared using a combination of six water quality parameters*. Two of the lakes had less median total phosphorus, none of the lakes had less median dissolved phosphorus and inorganic nitrogen, three had less mean chlorophyll a, and none of the other lakes had greater mean Secchi disc transparency. Some depression of dissolved oxygen with depth occurred in July.

Survey limnologists noted moderate amounts of surface algae and submerged and emergent macrophytes in the shallow coves and

* See Appendix A.

along the shoreline. Periodic impairment of use of the lake due to excessive aquatic vegetation has been reported (Peterson, 1975).

B. Rate-Limiting Nutrient:

The algal assay results indicate that Pelican Lake was nitrogen limited at the time the sample was taken (09/13/74). The lake data indicate nitrogen limitation at all sampling times.

III. LAKE CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 0.50 kilometers^2.
2. Mean depth: 3.1 meters.
3. Maximum depth: 9.1 meters.
4. Volume: 1.550×10^6 m^3.
5. Mean hydraulic retention time: Unknown.

B. Precipitation*:

1. Year of sampling: 53.1 centimeters.
2. Mean annual: 47.0 centimeters.

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† Table of metric conversions--Appendix B.
†† Henegar, 1975.
* See Working Paper No. 175, "...Survey Methods, 1973-1976.

IV. LAKE WATER QUALITY SUMMARY

Pelican Lake was sampled two times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter (ice cover prevented sampling in April). Each time, samples for physical and chemical parameters were collected from a number of depths at one station on the lake (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was collected for phytoplankton identification and enumeration, and a similar sample was taken for chlorophyll a analysis. During the September visit, a single 18.9-liter depth-integrated sample was collected for algal assays. The maximum depth sampled was 5.8 meters.

The sampling results are presented in full in Appendix C and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR PELICAN LAKE
STORET CODE 3811

PARAMETER	1ST SAMPLING (7/17/74) 1 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (9/13/74) 1 SITES RANGE	MEAN	MEDIAN	0 SITES RANGE	MEAN	MEDIAN
TEMP (C)	12.7 - 25.1	20.6	22.3	12.1 - 12.5	12.3	12.4	******	********	********
DISS OXY (MG/L)	2.2 - 8.2	5.2	5.2	7.2 - 8.0	7.7	7.8	******	********	********
CNDCTVY (MCROMO)	438. - 562.	518.	536.	354. - 357.	355.	355.	******	********	********
PH (STAND UNITS)	8.3 - 9.0	8.6	8.6	8.5 - 8.5	8.5	8.5	******	********	********
TOT ALK (MG/L)	272. - 304.	286.	283.	288. - 312.	300.	300.	******	********	********
TOT P (MG/L)	0.025 - 0.034	0.029	0.028	0.034 - 0.036	0.035	0.036	******	********	********
ORTHO P (MG/L)	0.006 - 0.009	0.007	0.006	0.006 - 0.007	0.006	0.006	******	********	********
NO2+NO3 (MG/L)	0.020 - 0.060	0.035	0.030	0.020 - 0.020	0.020	0.020	******	********	********
AMMONIA (MG/L)	0.020 - 0.040	0.030	0.030	0.050 - 0.050	0.050	0.050	******	********	********
KJEL N (MG/L)	1.300 - 1.400	1.350	1.350	1.200 - 1.600	1.333	1.200	******	********	********
INORG N (MG/L)	0.040 - 0.100	0.065	0.060	0.070 - 0.070	0.070	0.070	******	********	********
TOTAL N (MG/L)	1.320 - 1.460	1.385	1.380	1.220 - 1.620	1.353	1.220	******	********	********
CHLRPYL A (UG/L)	13.6 - 13.6	13.6	13.6	8.3 - 8.3	8.3	8.3	******	********	********
SECCHI (METERS)	4.9 - 4.9	4.9	4.9	2.0 - 2.0	2.0	2.0	******	********	********

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
07/17/74	1. Fragilaria sp.	883
	2. Cryptomonas sp.	321
	3. Oscillatoria sp.	321
	4. Microcystis sp.	120
	5. Nitzschia sp.	40
	Total	1,685
09/13/74	1. Fragilaria sp.	2,526
	2. Microcystis sp.	450
	3. Aphanizomenon sp.	173
	4. Anabaena sp.	104
	5. Cryptomonas sp.	104
	Other genera	311
	Total	3,668

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
07/17/74	1	13.6
09/13/74	1	8.3

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.010	0.081	2.6
0.050 P	0.060	0.081	3.2
0.050 P + 1.0 N	0.060	1.081	28.9
1.0 N	0.010	1.081	4.0

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Pelican Lake was moderately high at the time the sample was collected (09/13/74). Also, the lack of significant growth response with the addition of phosphorus until nitrogen was also added indicates the lake was nitrogen limited at that time. Note that the addition of nitrogen alone resulted in a yield greater than that of the control.

The lake data also indicate nitrogen limitation. The mean inorganic nitrogen/orthophosphorus ratios were 9/1 in July and 11/1 in September, and nitrogen limitation would be expected.

V. LITERATURE REVIEWED

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_____., 1975. Personal communication (State lake classification). ND Dept. of Health, Bismarck.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

10<

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
3801	LAKE ASHTABULA	0.260	0.160	472.250	40.892	10.600	0.170
3802	LAKE AUDUBON	0.087	0.220	446.222	11.322	11.000	0.015
3803	BRUSH LAKE	0.066	0.095	449.143	29.114	9.000	0.010
3804	LAKE DARLING	0.274	0.250	466.750	60.075	11.600	0.180
3805	DEVILS LAKE	0.630	0.140	449.333	38.508	14.600	0.469
3806	JAMESTOWN RESERVOIR	0.144	0.365	438.667	19.400	8.800	0.078
3807	LAKE LA MOURE	0.438	0.380	421.400	19.720	15.000	0.290
3808	MATEJCEK LAKE	0.228	0.440	475.167	2.683	14.400	0.179
3809	LAKE METIGOSHE	0.032	0.080	389.167	10.367	9.000	0.010
3811	PELICAN LAKE	0.034	0.070	364.500	10.950	12.800	0.006
3812	LAKE SAKAKAWEA (GARRISON	0.016	0.150	408.733	6.883	10.800	0.007
3813	SPIRIT WOOD LAKE	0.156	0.290	417.833	34.667	15.000	0.082
3814	SWEET BRIAR RESERVOIR	0.092	0.090	440.800	39.000	8.800	0.031
3815	WHITMAN LAKE	0.260	0.260	478.333	27.067	9.200	0.185

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES) i1<

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
3801	LAKE ASHTABULA	27 (3)	54 (7)	15 (2)	8 (1)	62 (8)	38 (5)	204
3802	LAKE AUDUBON	69 (9)	46 (6)	46 (6)	69 (9)	46 (6)	69 (9)	345
3803	BRUSH LAKE	77 (10)	77 (10)	38 (5)	38 (5)	81 (10)	81 (10)	392
3804	LAKE DARLING	15 (2)	38 (5)	23 (3)	0 (0)	38 (5)	23 (3)	137
3805	DEVILS LAKE	0 (0)	69 (9)	31 (4)	23 (3)	15 (2)	0 (0)	138
3806	JAMESTOWN RESERVOIR	54 (7)	15 (2)	62 (8)	62 (8)	96 (12)	54 (7)	343
3807	LAKE LA MOURE	8 (1)	8 (1)	69 (9)	54 (7)	4 (0)	8 (1)	151
3808	MATEJCEK LAKE	38 (5)	0 (0)	8 (1)	100 (13)	23 (3)	31 (4)	200
3809	LAKE METIGOSHE	92 (12)	92 (12)	92 (12)	85 (11)	81 (10)	81 (10)	523
3811	PELICAN LAKE	85 (11)	100 (13)	100 (13)	77 (10)	31 (4)	100 (13)	493
3812	LAKE SAKAKAWEA (GARRISON	100 (13)	62 (8)	85 (11)	92 (12)	54 (7)	92 (12)	485
3813	SPIRIT WOOD LAKE	46 (6)	23 (3)	77 (10)	31 (4)	4 (0)	46 (6)	227
3814	SWEET BRIAR RESERVOIR	62 (8)	85 (11)	54 (7)	15 (2)	96 (12)	62 (8)	374
3815	WHITMAN LAKE	27 (3)	31 (4)	0 (0)	46 (6)	69 (9)	15 (2)	188

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3809	LAKE METIGOSHE	523
2	3811	PELICAN LAKE	493
3	3812	LAKE SAKAKAWEA (GARRISON	485
4	3803	BRUSH LAKE	392
5	3814	SWEET BRIAR RESERVOIR	374
6	3802	LAKE AUDUBON	345
7	3806	JAMESTOWN RESERVOIR	343
8	3813	SPIRIT WOOD LAKE	227
9	3801	LAKE ASHTABULA	204
10	3808	MATEJCEK LAKE	200
11	3815	WHITMAN LAKE	138
12	3807	LAKE LA MOURE	151
13	3805	DEVILS LAKE	138
14	3804	LAKE DARLING	137

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

RETRIEVAL DATE 74/09/16

381101
48 5c 41.0 100 16 04.0 3
16< PELICAN LAKE
38093 NORTH DAKOTA

11EPALES 21112v2
0022 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/07/17	15	15 0000	25.1	7.6	192	562	9.00	282	0.030	1.400	0.030	0.006
	15	15 0005	25.1	8.2		559	8.90	284	0.020	1.300	0.020	0.006
	15	15 0015	19.6	2.2		512	8.40	304	0.030	1.300	0.030	0.007
	15	15 0019	12.7	2.9		438	8.30	272	0.040	1.400	0.060	0.009
74/09/13	12	30 0000	12.5	7.8	79	355	8.49	300	0.050	1.600	0.020K	0.006
	12	30 0009	12.4	8.0		357	8.51	288	0.050	1.200	0.020K	0.006
	12	30 0017	12.1	7.2		354	8.51	312	0.050	1.200	0.020K	0.007

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/07/17	15	15 0000	0.025	13.6	
	15	15 0005	0.029		
	15	15 0015	0.028		
	15	15 0019	0.034		1.0
74/09/13	12	30 0000	0.036	8.3	
	12	30 0003			50.0
	12	30 0009	0.036		
	12	30 0011			5.0
	12	30 0017	0.034		1.0

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX C

PHYSICAL and CHEMICAL DATA